European Journal of Clinical Nutrition www.nature.com/ejcn

BRIEF COMMUNICATION OPEN

Check for updates

Prevalence of anemia among children aged 6–59 months in the Ntele camp for internally displaced persons (Cabo Delgado, Mozambique): a preliminary study

Manuel Mussa Aly[1,7], Cristiana Berti[2,7]✉, Felício Chemane[3], Cesar Macuelo[3], Kodak Raúl Marroda[4], Adriano La Vecchia[2,5], Carlo Agostoni[2,6] and Mattia Baglioni[4,7]

In July 2022, we conducted a pilot cross-sectional study, within a project funded by the United Nations International Children's Emergency Fund, to investigate the prevalence and predictors of anemia in children aged 6–59 months living in the Ntele camp (Mozambique), created for internally displaced persons (IDPs). We analyzed blood samples for hemoglobin (Hb) and *Plasmodium* antigens; stool and urine for parasites. Associations between variables were assessed by performing univariate and multivariate logistic regressions. Based on the World Health Organization's Hb cut-offs, we defined anemia (Hb < 110 g/L) as mild (Hb = 100–109 g/L), moderate (Hb = 70–99 g/L), and severe (Hb < 70 g/L). We included 245 children, 212 (83%) were anemic, with 30 (12%) being severely anemic, and 95 (39%) suffered from malaria. Children with moderate-severe anemia were younger than others (mean age = 25.3 and 29.5 months, respectively; $p = 0.02$). Malaria was positively correlated with moderate to severe anemia (crude OR [95%CI] = 2.5 [1.5-4.5]; sex and age-adjusted OR [95%CI] = 3.1 [1.7-5.6]). Anemia in children under 5 years of age represents an urgent public health threat in the IDPs camp of Ntele, with malaria potentially making them much more susceptible to moderate-severe anemia and other diseases.

European Journal of Clinical Nutrition; https://doi.org/10.1038/s41430-024-01516-7

BACKGROUND

Anemia persists as a public health problem on a global level, mostly in children less than 5 years, with infants and children under 2 years of age, women of reproductive age, and pregnant women being particularly vulnerable [1, 2]. Childhood anemia may result in growth retardation, impaired motor and cognitive development, and increased morbidity and mortality [2]. Despite the complex multi-factorial etiology, iron deficiency anemia is the most common cause contributing to childhood anemia. Malaria and helminthic infestations also play a great part particularly in resource-poor countries, along with low accessibility to health services, food insecurity, and poor hygiene conditions [2].

According to the recent national surveys conducted in 2011 and 2018 in Mozambique, the province of Cabo Delgado registered an improvement in the combined prevalence of moderate-severe anemia, defined as hemoglobin (Hb) below 80 g/L, that decreased from 45 to 24% [3, 4]. Nevertheless, a 24% prevalence is of particular concern in a conflict setting where access to healthcare and general living conditions may be challenging and exacerbate risk. The attacks perpetrated by non-state armed groups on civilians and government facilities since 2017 exacerbated an already precarious socio-economic context constraining further access to basic services, including health services.

As of the end of 2020, the displaced families fleeing the conflict zones started to seek refuge in the Southern districts of the province, among which Montepuez. Therefore, the Ntele resettlement site was created by the local government to give internally displaced persons (IDPs) humanitarian assistance [5]. We conducted a pilot study within the scope of a project funded by the United Nations International Children's Emergency Fund (UNICEF) and implemented by AVSI that aimed to improve the nutritional status of children aged 0–59 months. The main objective of the research was to determine the prevalence and predictors of anemia in children aged 6–59 months.

METHODS

Subjects and setting

In July 2022, we performed a cross-sectional study. Eligible participants were children aged 6–59 months living in the IDPs camp of Ntele, a peri-urban area in the Montepuez district (Cabo Delgado, Mozambique) covering an area of nearly 300 hectares. As of April 2022, the camp area covered ~300 hectares, while its population amounted to 18,007 individuals, out of which 5,245 were below 5 years old, and 3652 households. The sample size was defined using the ENA for the SMART application available online [6]. We used the systematic random sampling approach because the study population was between 1000 and 5000 basic

[1]NIOP, Nucleo de Investigação Operacional de Pemba, Pemba, Cabo Delgado, Mozambique. [2]Pediatric Unit, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, Italy. [3]Serviço Distrital de Saúde, Mulher e Acção Social de Montepuez, Montepuez, Cabo Delgado, Mozambique. [4]AVSI Foundation Mozambique, Pemba, Cabo Delgado, Mozambique. [5]Department of Medicine and Surgery, University of Milano-Bicocca, Monza, Italy. [6]Department of Clinical Sciences and Community Health, University of Milan, Milan, Italy. [7]These authors contributed equally: Manuel Mussa Aly, Cristiana Berti, Mattia Baglioni. ✉email: cristiana.berti2@gmail.com

Received: 27 July 2023 Revised: 18 September 2024 Accepted: 23 September 2024
Published online: 28 September 2024

Table 1. Prevalence of anemia and malaria among children 6–59 months in the Ntele camp for internally displaced persons, by sex, age, and total sample.

	Sex		Age in months			
	F (*n* = 120)	M (*n* = 125)	6–11 (*n* = 21)	12–23 (*n* = 66)	24–59 (*n* = 158)	TOT (*n* = 245)
Age in months, mean (SD)	28.5 (12.8)	25.9 (13.9)	7.7 (1.4)	15.2 (3.2)	34.8 (10.3)	27.2 (13.4)
Hemoglobin[a] (g/L), mean (SD)	9.4 (1.8)	9.1 (2)	9.1 (2.3)	9.0 (1.9)	9.4 (1.9)	9.3 (1.9)
Prevalence of anemia[a], *n* (%)						
No anemia (≥110 g/L)	23 (19)	19 (15)	5 (24)	11 (17)	26 (17)	42 (17)
Mild (100–109 g/L)	30 (25)	25 (20)	1 (5)	12 (19)	42 (27)	55 (23)
Moderate (99–70 g/L)	55 (46)	60 (49)	12 (57)	32 (49)	71 (45)	115 (48)
Severe (<70 g/L)	11 (9)	19 (15)	3 (14)	10 (15)	17 (11)	30 (12)
Positive malaria test, *n* (%)	48 (40)	47 (38)	4 (19)	19 (29)	72 (46)	95 (39)

Anemia was define using WHO cut off [7].
[a]Three patients had missing data on hemoglobin levels.

sampling units, a comprehensive list of households of the IDP camp was already available, and dwellings were arranged in rows and/or blocks within a defined geographical area [6].

Data collection

Eight trained professional enumerators, locally recruited, visited the households, provided verbal information about the study, and invited caregivers to join the study point. Once informed consent was obtained from caregivers, data were collected using a Case Report Form and eventually registered in a database through Microsoft Excel. Children's age was reported by the caregivers. At the time of the enrollment, a professional technician tested children's capillary blood for Hb concentration on-site using a hemoglobinometer (HemoCue 301 System kit), and *Plasmodium* antigens (i.e., malaria) through a rapid diagnostic test [6]. At the same time, the technician provided the caregivers with the tools and instructions for collecting their children's urine and stool to be returned in 2 days to a collection point. Samples were stored at the study point in a Coleman portable refrigerator for a maximum of 2 h and then taken to the laboratory at the Rural Hospital of Montepuez. Stool and urine samples were analyzed for parasites by microscopic techniques.

Statistical analyses

Statistical analyses were performed using the software SPSS 28.0.1.1 and RStudio 2022.12.0 + 353. We computed frequencies, mean, and prevalence. Based on the Hb cut-offs settled by the World Health Organization (WHO) [7], we defined anemia (Hb < 110 g/L) as mild (Hb = 100–109 g/L), moderate (Hb = 70–99 g/L), and severe (Hb < 70 g/L). We compared the age and sex of children with moderate-severe anemia (Hb < 100 g/L) with other children (Hb ≥ 100 g/L) using a *t*-test and a chi-square test. To assess the correlation between malaria and anemia prevalence, we performed univariate and multivariate (sex and age-adjusted) logistic regressions using moderate to severe anemia as the dependent variable and malaria test result as the independent variable.

The study was conducted with the collaboration of the District Health Department (*Serviço Distrital de Saúde, Mulher e Acção Social, SDSMAS*) of Montepuez and local leaders.

RESULTS

We included a total of 245 children aged 6–59 months. Whilst we could test all the subjects for malaria and 242 (99%) children for anemia, urine and stool samples were gathered only from 56 (23%) and 46 (19%) children, respectively. Despite the sensitization sessions on the objectives of the research intended for IDPs camp leaders that were carried out before the field activities, we registered a high rate of denial by caregivers probably due to cultural taboos that we did not investigate here.

Table 1 shows the prevalence of anemia and malaria in our population. We reported 200 (83%) anemic children, with 30 (12%) severely anemic and 115 (48%) moderately anemic.

Table 2. Odds ratios (ORs) and 95% confidence intervals (CIs) between moderate-severe anemia (hemoglobin below 100 g/L) as dependent variable and malaria in the study population, crude and adjusted by age and sex.

Independent variable	OR	CIs	*p*-value
Malaria	2.5	1.5–4.5	0.001
Malaria + age	3.1	1.7–5.6	<0.001
Malaria + age + sex	3.1	1.7–5.7	<0.001

Almost one-third (39%) of subjects suffered from malaria. Parasites were assessed in the urine of 4 children and the stool of 1 child. Due to the small number of collected samples, we did not perform statistical analyses on urine and stool.

Children with moderate-severe anemia were younger compared to other children (mean age = 25.3 and 29.5 months, respectively; $p = 0.02$), while we did not find any sex difference ($p = 0.2$), with 55% of males in the moderate-severe anemic and 45% in the mild or non-anemic children.

Table 2 gives the Odds Ratios (ORs), Confidence Intervals (CIs), and p-value between moderate to severe anemia (Hb < 100 g/L) and malaria in children 6–59 months. We found that a positive rapid test to malaria was positively correlated with moderate to severe anemia (crude OR [95%CI] = 2.5 [1.5-4.5]; sex and age-adjusted OR [95%CI] = 3.1 [1.7-5.6]).

DISCUSSION

To our knowledge, no published literature investigated the prevalence of anemia and malaria among children under 5 years of age in the IDPs camp of Ntele, Montepuez. The IDPs of Ntele camp live in shelters whose structure is made up of wood, mud bricks, and tarpaulins. In the most precarious cases, the shelter space capacity is not fit to host the number of household members. Nevertheless, this very much depends on the households' access to means to build new shelters that comply with basic living standards. In this setting, communal latrines are often shared among two or more neighbor households. The camp inhabitants' livelihood and access to food depend mainly on humanitarian aid through the provision of seeds for agriculture, support to basic livelihood activities (e.g., petty trade, sewing machines), and food rations. We reported a high prevalence of childhood anemia (83%), which is consistent with Muhajarine and colleagues' [8] results (86%) about Cabo Delgado in 2018. Mozambique is acknowledged as one of the sub-Saharan African countries with the highest prevalence of childhood anemia (69%

in 2019) [8]. Maulide Cane and colleagues observed an anemia prevalence of 62% among children aged 6–59 months in a quaternary health facility in Maputo City Province [9]. Our data about malaria in Mozambique are comparable to previous findings that reported a stable rate of around 39% in recent years [8]. We found a correlation between malaria status and moderate to severe anemia. Twenty years of surveillance data at Manhiça District Hospital in Mozambique showed that in 2006–2017 malaria represented around 30–40% of pediatric hospital admissions, remaining a leading cause of disease and healthcare system use [10]. In sub-Saharan Africa, malaria caused by *Plasmodium* parasites is a common cause of childhood anemia [11] which, in turn, makes children much more susceptible to severe anemia, by substantially decreasing Hb levels [11] and other severe diseases. More than two-thirds of malaria deaths occur in this population [2]. It is worth considering that hemoglobin concentration could vary between seasons. Potential higher rates of anemia during the dry season, notably before the harvest, may be recorded due to the lack of a diversified diet and, therefore, of micronutrients, as reported by recent research [12]. We could not estimate the association between anemia and intestinal and urinary parasite infestation due to the limited samples collected. A four-arm randomized trial found no differences in anemia prevalence between the groups treated with different approaches to intestinal parasites in children below 59 months (annual single dose of albendazole or test-and-treat every 4 months only the child or the child and all the household members) [13].

The current community-based cross-sectional study provides evidence that anemia in children under 5 years of age represents an urgent public health threat in IDPs camp of Ntele. The lack of data disaggregation may neglect the inequities among the swaths of the population living in different geographical areas (e.g., rural and urban). This suggests the need to focus on child and maternal health at the provincial and district levels [8, 9].

Although the cross-sectional design of the study limits the causal inference, our analysis provides baseline information to guide the development of initiatives aimed at improving the health of the most vulnerable population in Cabo Delgado. Regarding the association between anemia and malaria, the results indicate that these conditions are strictly correlated in the study population. In 2015, a baseline census in Magude, South Mozambique, showed that only 27% of the children younger than 5 years slept below bed nets the previous night [14]. Even if we do not have data on bed net use in Ntele camp, we found that 39% tested positive for malaria, indicating that more effort should be made in malaria prevention.

DATA AVAILABILITY

The data that support the findings of this study are available from the authors upon reasonable request.

REFERENCES

1. Sun J, Wu H, Zhao M, Magnussen CG, Xi B. Prevalence and changes of anemia among young children and women in 47 low- and middle-income countries, 2000–2018. eClinicalMedicine. 2021;41:101136.
2. Chaparro CM, Suchdev PS. Anemia epidemiology, pathophysiology, and etiology in low- and middle-income countries. Ann N Y Acad Sci. 2019;1450:15–31. https://doi.org/10.1111/nyas.14092.
3. Instituto Nacional de Saúde (INS), ICF. Instituto Nacional de Saúde (INS) e ICF. 2019. Inquérito Nacional sobre Indicadores de Malária em Moçambique 2018. Maputo, Moçambique. Rockville, Maryland, EUA: INS e ICF. https://dhsprogram.com/pubs/pdf/MIS33/MIS33.pdf
4. Ministério da Saúde (MISAU), Instituto Nacional de Estatística (INE), ICF Internacional (ICFI). Moçambique Inquérito Demográfico e de Saúde 2011. 2013.
5. DTM, IOM Displacement tracking matrix, 2021. Baseline Assesment Round 14 - November 2021 - Displacement Tracking Matrix (DTM). IOM. https://dtm.iom.int/reports/northern-mozambique-crisis-dtm-baseline-assessment-report-round-14-november-2021
6. Mbunga BK, Mapatano MA, Strand TA, Gjengedal ELF, Akilimali PZ, Engebretsen IMS. Prevalence of anemia, iron-deficiency anemia, and associated factors among children aged 1–5 years in the rural, malaria-endemic setting of Popokabaka, Democratic Republic of Congo: a cross-sectional study. Nutrients. 2021;13:1010.
7. WHO. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. 2011. https://apps.who.int/iris/bitstream/handle/10665/85839/WHO_NMH_NHD_MNM_11.1_eng.pdf?sequence=22&isAllowed=y.
8. Muhajarine N, Adeyinka DA, Matandalasse M, Chicumbe S. Inequities in childhood anaemia at provincial borders in Mozambique: cross-sectional study results from multilevel Bayesian analysis of 2018 National Malaria Indicator Survey. BMJ Open. 2021;11:e051395.
9. Maulide Cane R, Keita Y, Lambo L, Pambo E, Gonçalves MP, Varandas L, et al. Prevalence and factors related to anaemia in children aged 6–59 months attending a quaternary health facility in Maputo, Mozambique. Glob Public Health. 2023;18:2278876.
10. Guinovart C, Sigaúque B, Bassat Q, Loscertales MP, Nhampossa T, Acácio S, et al. The epidemiology of severe malaria at Manhiça District Hospital, Mozambique: a retrospective analysis of 20 years of malaria admissions surveillance data. Lancet Glob Health. 2022;10:e873–e881.
11. Starck T, Dambach P, Rouamba T, Tinto H, Osier F, Oldenburg CE, et al. The effect of malaria on childhood anemia in a quasi-experimental study of 7,384 twins from 23 Sub-Saharan African countries. Front Public Health. 2022;10:1009865.
12. Egbi G, Tohuoenou MM, Glover-Amengor M, Adom T. The impact of seasonal variation on anemia and nutritional status with associated factors in 6–12 years Ghanaian school age children in peri-urban communities. Hum Nutr Metab. 2021;26:200135.
13. Gasparinho C, Gonçalves MH, Chissaque A, Silva GL, Fortes F, Gonçalves L. Wasting, stunting, and anemia in Angolan children after deworming with Albendazole or a test-and-treat approach for intestinal parasites: binary longitudinal models with temporal structure in a four-arm randomized trial. Nutrients. 2022;14:2185.
14. Galatas B, Nhacolo A, Marti H, Munguambe H, Jamise E, Guinovart C, et al. Demographic and health community-based surveys to inform a malaria elimination project in Magude district, southern Mozambique. BMJ Open. 2020;10:e033985.

ACKNOWLEDGEMENTS

This study was made possible thanks to a collaborative process between the *SDSMAS (Serviço Distrital de Saúde, Mulher e Acção Social)* of Montepuez and NIOP *(Nucleo de Investigação Operacional de Pemba)* that provided human resources for the data collection process and the laboratory analysis. Our deepest gratitude is also for the team of enumerators that worked daily and tirelessly in the field, and for the mothers/caregivers that took the time to participate in the survey. To this team goes our special thanks.

AUTHOR CONTRIBUTIONS

MMA, CB, and MB designed the study; MMA, FC and KRM were involved in data collection. CB, FC, CM, and ALV performed data analysis. CB, ALV, CA and MB provided input in the paper draft preparation. All authors contributed to revise the paper to its final version, and approved the submitted version. CB and MB had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

FUNDING

Study funded by the United Nations International Children's Emergency Fund (UNICEF) under the project "Promoting life-saving nutrition interventions and the support to Integrated Mobile Brigades in Cabo Delgado", implemented by AVSI Foundation. Study partly supported by a grant of the Italian Ministry of Health for IRCCS (Ricerca Corrente).

COMPETING INTERESTS

The authors declare no competing interests.

ETHICAL APPROVAL

The research protocol was approved by the National Bioethics Committee for Health in Mozambique (63/CNSB/2022).

ADDITIONAL INFORMATION

Correspondence and requests for materials should be addressed to Cristiana Berti.

Reprints and permission information is available at http://www.nature.com/reprints

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.